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23. Aerogeophysical Investigations over the Bowers Mountains, North Victoria Land, Antarctica

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INTRODUCTION

An aerogeophysical survey was planned as major program for the GANOVEX VI expedition over the northern coastal area of North Victoria Land including onshore sections across the Bowers Mountains, the lower Rennick Glacier, the Wilson Hills, and the adjacent parts of the Polar Plateau. As this program was set up for the second part of aerogeophysical work during the 1990/91 austral season, it was strongly influenced by anything encountered during the first phase at McMurdo (see DAMASKE et al. this volume). Delays stemming from the first leg caused cuts in the North Victoria Land survey right from the beginning. Bad weather conditions and the early termination of survey flights due to various reasons limited the northern program to a fraction of what was originally planned.

The remaining scientific work concentrated on the area of the Bowers Mountains. During GANOVEX V the northernmost parts of the Bowers structural zone were surveyed (DAMASKE & BOSUM in press). Only an isolated magnetic anomaly near Mt. Glasgow showed up prominently, but this was recorded on one single flight line only which passed near the top of the mountain. It was left for the GANOVEX VI survey to investigate this important structural zone in more detail and with a better coverage to come up with at least a complete picture of its magnetic appearance.

To the east of the Bowers structural zone a quiet magnetic pattern seems to be characteristic for the rocks of the Robertson Bay Terrane. However, only a small section was covered during the GANOVEX V aeromagnetic survey. A larger part covered now will help to understand its geotectonic setting in relation to the Bowers zone in the context of the still open question of the existence of an extended thrust system in northeastern Victoria Land.

According to the results of the GANOVEX V survey the Rennick Graben seems to be divided by a NW-SE striking magnetic lineament. The northern section is characterized by strong, positive anomalies whilst south of this line no distinct anomalies are seen over the area covered so far. The magnetic lineament seems to continue southeast as is indicated by a few single lines crossing the area south of the densely spaced GANOVEX V grid. The few densely spaced lines flown during GANOVEX VI cover this area and will allow a better understanding of this important magnetic feature.

SET UP OF THE SURVEY AND INSTRUMENTATION

The grid remaining for the GANOVEX VI survey is a block of 180 x 290 km focusing over the Bowers Mountains (Fig. 1). The profile lines run approximately E-W with a spacing of 4.4 km. The N-S aligned tie-lines are separated by 22 km. The orientation of the grid lines is the same as for the GANOVEX IV survey, the details of the projection used are described in BACHEM et al. (1989). The survey altitude chosen over mountainous terrain was 9,000 ft (2,750 m) corresponding to a barometric flight altitude of 9,500 ft. The difference is due to the

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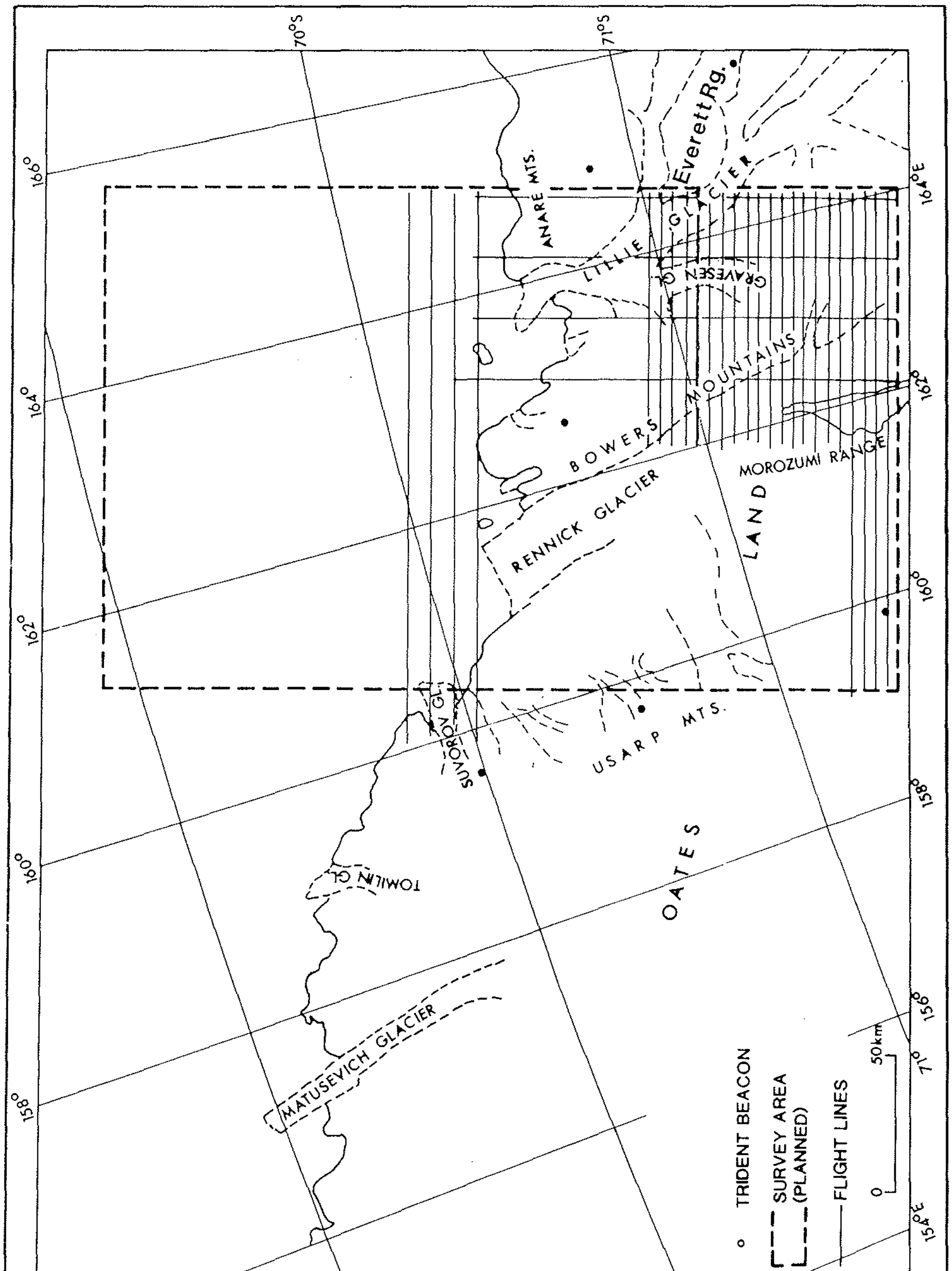

Fig. 1: Aerogeophysical survey area in North Victoria Land and the lines flown. Trident transmitter locations are shown by dots.

Abb. 1: Geplantes Meßnetz für das nördliche Victorialand und tatsächlich geflogene Linien. Punkte markieren die Position der Trident Navigationssender.

non-standard atmosphere over Antarctica, the value of 500 ft difference in this altitude range stems from scattered observations during GANOVEX V (DAMASKE 1990) and extrapolating the GPS-heights over barometric pressure curve for northern Victoria Land by REITMAYR (pers. comm). The lines over the coastal section, i.e. over fast ice and open water were flown in 2,000 ft (610 m) radar altitude.

The scientific equipment, such as magnetometers, data acquisition, and the Trident navigation system was the same as for the survey over the Ross Ice Shelf in the earlier part of the season and is described in DAMASKE et al. (this volume). In addition, for flights over the ice covered areas, the radio-echo-sounding system ARES of the University of Münster was installed in the *Polar 2* aircraft to estimate bedrock topography.

Geomagnetic activity was monitored at a base station a few hundred meters away from the base camp for the air operations at Cape Williams. The times best suited for the aeromagnetic survey flights were found to be the same hours of the day as known from base station recordings in this area during previous years (DAMASKE & MEINHARDT 1982, DAMASKE in press): the least disturbed interval is from the late afternoon till the morning hours, local time.

DATA ACQUISITION, PRELIMINARY DATA PROCESSING AND FIRST RESULTS

The two aircraft (*Polar 2* and *Polar 4*) arrived at the expedition's northern base at Cape Williams on December 26, 1990. Until December 31 the six Trident navigation transmitters were installed with the help of the expedition helicopters; at the same time the science section of *Polar 2* was re-installed and supplemented by the ARES system.

The first survey flight with *Polar 2* took place on January 1, 1991. Bad weather prevented flying on most days until the survey came to an abrupt end after the *Polar 4* was damaged during landing. Until then an evaluable area of 90 x 90 km had been covered. The 3,700 km survey lines were flown during 21.9 hours flying time (12.8 hours on line) on a total of six flights.

To obtain a first view on the results a representative flightline was chosen covering four different areas of geophysical and geological interest: flightline 495521 (marked in Fig. 1) starts over the Rennick Glacier, crosses the Bowers Mountains and the Lillie Glacier ends finally over the Everett Range. Due to the limited range of the radar altitude measurements in combination with the high flight level over mountainous ground only parts of the contour surface (over the Bowers Mountains) of the line can be plotted as is shown in Fig. 2 (lower part).

The INS navigation is the base for positioning all data shown here. Only small deviations in the order of 3° on a survey heading of 288° needed to be corrected after the common main adjustments when entering the flightline. The line was flown in an E-W direction so that the flight actually begins on the right side of the plot in Figure 2. To minimize the directional errors during the flight the pilots were guided by the Trident navigation monitor indicating the actual deviation to adjust the autopilot. More precise evaluation of the present data can only be achieved by computing a compensation of the heading errors and merging the available Trident navigation data into the current data base.

From the original raw flight data a dataset of 1 Hz sampling rate was extracted and corrected whenever spikes and strongly disturbed data sequences made it necessary. The next step was the subtraction of the diurnal magnetic field variations, measured with a base station near Cape Williams field camp. The base station data had to be low pass filtered with a cut-off frequency of 30 minutes to prevent an illegal interpolation of local high frequency magnetic field disturbances to the in-flight measurements some hundred kilometers from the camp. The second basic reduction of the airborne magnetic data was the correction for the earth's magnetic field based on the IGRF model 1985.0.

The result is the reduced total field shown in Figure 2. Over the Rennick Glacier the reduced total field is slowly rising when approaching the Bowers Mountains, reaching its highest values shortly after passing the edge of the mountains, then decreasing with superposed local field variations in the order of ten kilometers wavelength. Another small positive magnetic anomaly is observed when leaving the Bowers Mountains and entering the Lil-

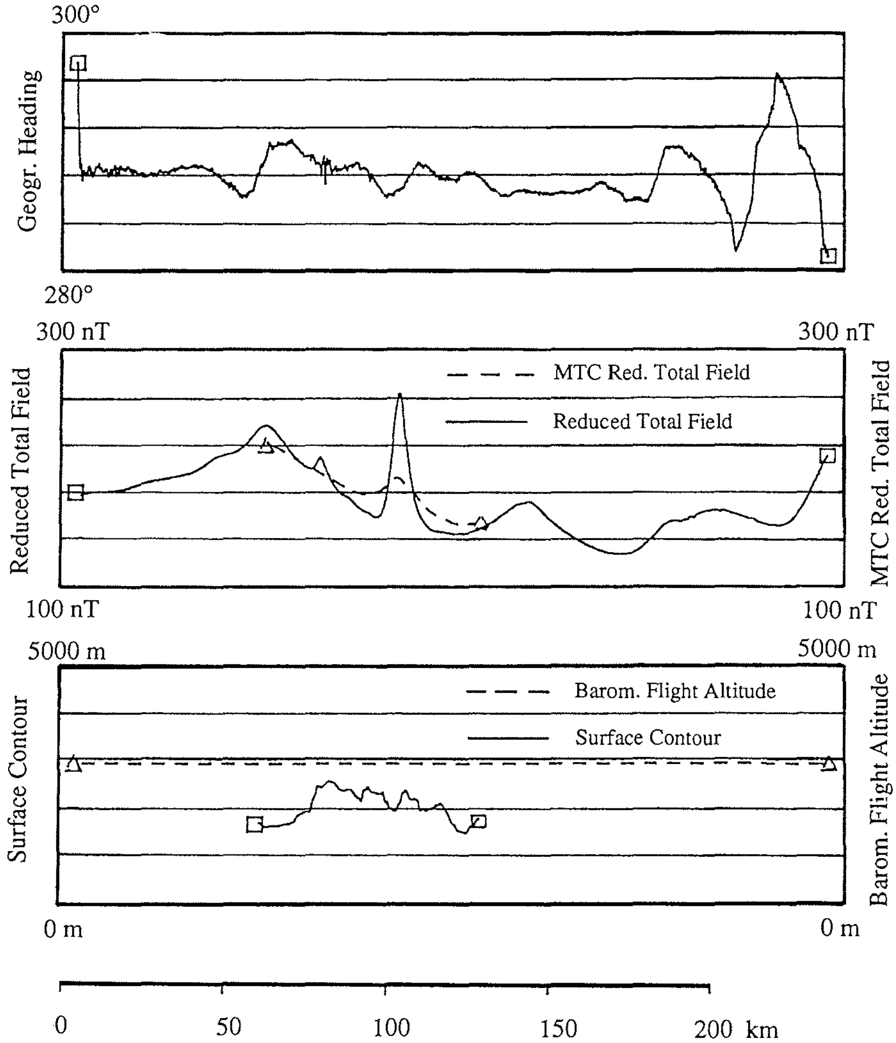

Fig. 2: Reduced total field data of survey line 495521. Shown on the bottom part of the figure is the contour surface as much as it can be derived from the radar altitude recordings. Upward continued data are shown above the reduced field values. The top of the Figure shows the geopgraphic heading of the aircraft. Note that the line is flown from right to left.

Abb. 2: Daten des reduzierten magnetischen Totalfelds von Meßlinie 495 521, geflogen von rechts nach links. Unten: Kontur des Gesteinsuntergrunds, abgeleitet von Radar-Höhenmessungen; darüber: reduzierte magnetische Felddaten, hochgerechnet auf 3,000 m Höhe; oben: Ausrichtung der Flugzeugachse.

lie Glacier, the total field turning into long wavelength variations over the Lillie Glacier and finally rising again above the Everett Range.

The relatively high and prominent positive magnetic anomaly seen east of the centre of the Bowers Mountains indicates a strong local magnetic source with an upper edge near the surface whilst the long wavelength anomaly over the Lillie Glacier is produced by a wide and deeply buried magnetic source. This is underlined by leveling the magnetic data to a constant altitude of 3,000 m from a quite stable flight level of 2,900 m (uncorrected altitude, see above) and using a mean terrane clearance algorithm (HANSEN & MIYASAKI 1984). These upward continued data are plotted also in Figure 2. The prominent positive anomaly in the total field data is now signifi-

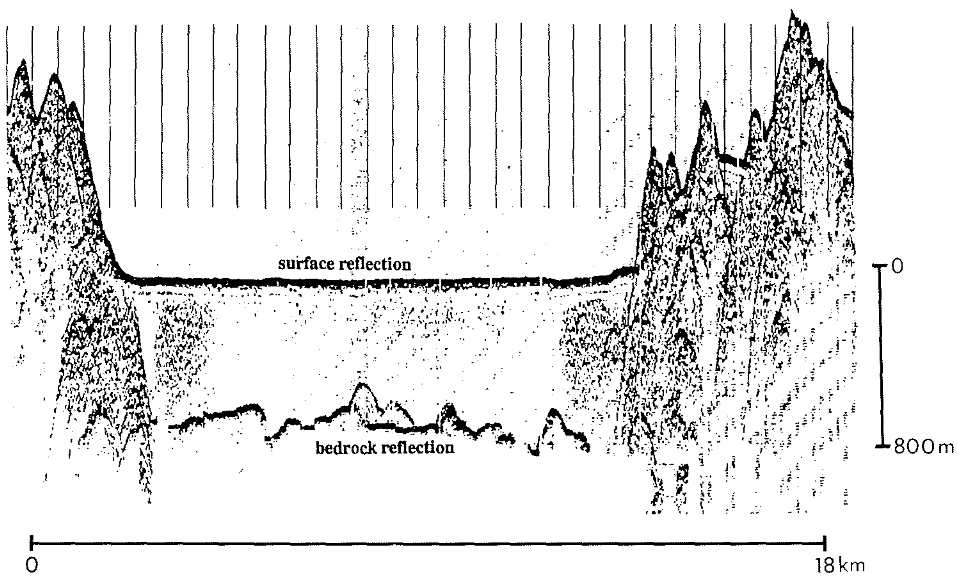

Fig. 3: Example of a fieldprint of an electromagnetic reflection (EMR) profile showing a glacier flanked by outcropping rocks. The location according to the uncorrected INS navigation data is between 71° 11' 23" S, 163° 06' 23" E and 71° 04' 37" S, 162° 43' 12" E in the Bowers Mountains.

Abb. 3: Vor-Ort-Ausdruck elektromagnetischer Reflexionsdaten (Eisdicken-Radar), die einen Gletscher flankiert von eisfreien Gesteinsvorkommen zeigen. Position nach unkorrigierter INS-Navigation 71° 11' 23" S, 163° 06' 23" E und 71° 04' 37" S, 162° 43' 12" E in den Bowers-Bergen.

cantly reduced while all other parts of the data record remain nearly unchanged. Since the radar altitude is needed for the mean terrain clearance algorithm only part of the data record could be computed.

In Figure 3 an example of a fieldprint of an electromagnetic reflection (EMR) profile is shown. The mountain areas are visible as hyperbolas right and left. In the glacier area the surface reflection and the bedrock reflection is marked. with a velocity for the electromagnetic wave in ice of 170 m/s one can determine the ice thickness as more than 800 m.

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